

**Texanol Benzyl Phthalate**  
**[CASRN 16883-83-3 or 32333-99-6]**

**Review of Toxicological Literature**

*Prepared for*

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## EXECUTIVE SUMMARY

Texanol benzyl phthalate was nominated by the National Institute of Environmental Health Sciences (NIEHS) for toxicity and carcinogenicity testing based on its high production volume (6.73 to 8.90 million lb [3050 to 4040 metric tons] annually) and suspicion of toxicity due to its structural similarity to butyl benzyl phthalate. The compound may be prepared by treating 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Texanol, a registered trademark of Eastman Chemical Company) with phthalic anhydride followed by treatment with benzyl chloride and neutralization.

Marketed as Santicizer<sup>®</sup> 278, Texanol benzyl phthalate is a versatile plasticizer for use in many resin systems, from automobile sealants to water-blown methylene diisocyanate (MDI)-based polyurethane foams. Its ability to increase durability, adhesion, and resistance to water spotting facilitates the development of high-performance paint and coating products.

OSHA and ACGIH have not established specific exposure limits for Texanol benzyl phthalate but have done so for several dialkyl phthalate esters. When discarded, the compound is not a hazardous waste, as defined by the Resource, Conservation and Recovery Act (RCRA), and it is also not considered hazardous under the Department of Transportation (DOT) regulations. It is, however, listed in the Toxic Substances Control Act (TSCA) Inventory. Texanol benzyl phthalate is included in the U.S. EPA High Production Volume (HPV) Challenge Program. It is also fully sponsored for Screening Information Data Set (SIDS) testing by 2000 by Solutia, Inc.

Results of biodegradation tests suggest that Texanol benzyl phthalate would be classified as "inherently biodegradable." It is virtually nontoxic in aquatic organisms; the acute toxicity value ( $EC_{50}$  and  $LC_{50}$ ) was  $> 100$  mg/L (0.220 mM).

For humans, the likely routes of exposure to Texanol benzyl phthalate are skin contact and inhalation. Very limited information on toxicity was located. It was reported to be practically non-irritating when tested on the skin and eyes of rabbits; the dermal  $LD_{50}$  value was  $> 10,000$  mg/kg (21.978 mmol/kg). A manufacturers safety data sheet reports that the chemical does not cause significant eye or skin irritation or toxicity, nor significant inhalation or ingestion toxicity.

In standard tests using bacterial cells, no genetic changes were observed with the compound.

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TEXANOL BENZYL PHTHALATE**

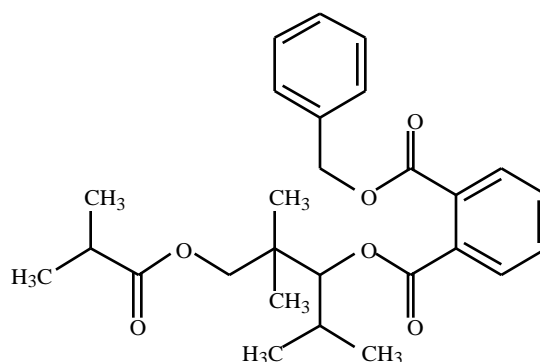
## 1.0 BASIS FOR NOMINATION

The nomination of Texanol benzyl phthalate by the National Institute of Environmental Health Sciences (NIEHS) for toxicity and carcinogenicity testing is based on its high production volume and suspicion of toxicity due to structural similarity to the phthalate ester butyl benzyl phthalate.

## 2.0 INTRODUCTION

### 2.1 Chemical Identification

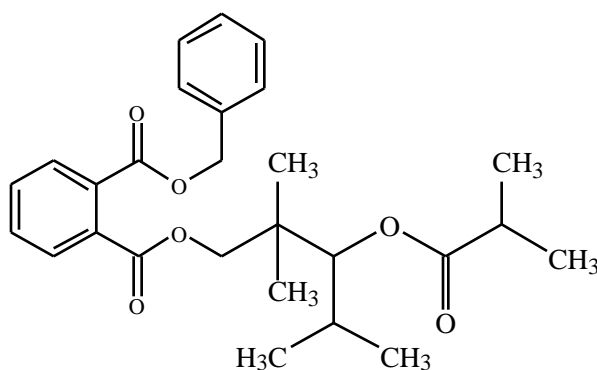
Texanol benzyl phthalate ( $C_{27}H_{34}O_6$ , mol. wt. = 455) is represented in the trade literature as if it is the product of esterification of the benzyl phthalate half ester with 2,2,4-trimethyl-1,3-pentanediol 1-isobutyrate (CASRN 77-68-9) (hereafter called the diol 1-isobutyrate), and the CASRN 16883-83-3 is used.



2,2,4-Trimethyl-1,3-pentanediol 1-isobutyrate benzyl phthalate

Texanol (CASRN 25265-77-4), as produced as a trade name product in the 1960s by Tennessee Eastman Co., was a 59:41 mixture of the diol 1-isobutyrate (primary alcohol moiety of the diol esterified) and the diol 3-isobutyrate (CASRN 18491-15-1) (secondary alcohol moiety esterified) (White et al., 1964). The structure and systematic chemical names of Texanol do not specify which hydroxy group of the diol is esterified. [Texanol is on the U.S. EPA OPPT High Production Volume List (U.S. EPA, 1998), but the diol 1-isobutyrate is not. The diol isobutyrate is produced by the self-condensation of isobutyraldehyde under basic conditions.

Some patented processes claim production of both isomers; others claim production of only the diol 1-isobutyrate and do not even mention the formation of the diol 3-isobutyrate.] The benzyl phthalate derived from Texanol (CASRN 32333-99-6) is represented by Chemical Abstracts Service as three separate and unconnected structures for the benzyl phthalate half ester, 2,2,4-trimethylpentane-1,3-diol, and isobutyric acid. If the Texanol produced today is still close to being a 59:41 mixture of the 1- and 3-isobutyrate monoesters, it would be expected to contain some fraction of the condensation product of the diol 3-isobutyrate as well as the first structure drawn above. That structure, whose CASRN was not identified, would be as follows:



Synonyms for the compound with CASRN 16883-83-3:

1,2-Benzenedicarboxylic acid, 2,2-dimethyl-1-(1-methylethyl)-3-(2-methyl-1-oxopropoxy)propyl phenylmethyl ester (9CI)  
 1,2-Benzenedicarboxylic acid, 2,2-dimethyl-1-(1-methylethyl)-3-(2-methyl-1-oxopropoxy)propyl phenylmethyl 1,2-benzenedicarboxylate  
 Isobutyric acid, 3-hydroxy-2,2,4-trimethylpentyl ester benzyl phthalate  
 1,3-Pentanediol, 2,2,4-trimethyl-, 3-(benzyl phthalate) isobutyrate  
 Phthalic acid, benzyl 3-hydroxy-1-isopropyl-2,2-dimethylpropyl ester isobutyrate\*  
 2,2,4-Trimethyl-1,3-pentanediol 1-isobutyrate benzyl phthalate

Synonyms for the compound with CASRN 32333-99-6:

1,2-Benzenedicarboxylic acid, mono(phenylmethyl) ester, ester with  
 2,2,4-trimethyl-1,3-pentanediol mono(2-methylpropanoate) (9CI)  
 Isobutyric acid, monoester with 2,2,4-trimethyl-1,3-pentanediol, benzyl phthalate  
 1,3-Pentanediol, 2,2,4-trimethyl-, benzyl phthalate isobutyrate  
 Phthalic acid, benzyl ester, ester with isobutyric acid monoester with  
 2,2,4-trimethyl-1,3-pentanediol (8CI)  
 Phthalic acid, benzyl ester, 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate ester\*  
 Santicizer® 278\*  
 2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate benzyl phthalate

Sources: ChemIDplus, 1999; MDL Inf. Serv., 1999; Registry, 1999

The producer gives the three names followed by asterisks as synonyms for Texanol benzyl phthalate and gives the CASRN as 16883-83-3 (Solutia Inc., 1997).

No analytical methods for determination of Texanol benzyl phthalate were located.

## 2.2 Physical-Chemical Properties

Property	Information	Reference
Physical State	Clear, oily, viscous liquid	Solutia Inc. (1997)
Odor	Slight characteristic	Solutia Inc. (1997)
Boiling Point (°C) @ 10 mm Hg	243	Solutia Inc. (1997)
@ 760 mm Hg	> 300	Solutia Inc. (1997)
Refractive Index @ 25 °C	1.519	Solutia Inc. (1997)
Specific Gravity @ 25 °C	1.10	Solutia Inc. (1997)
Solubility in Water @ 25 °C	Insoluble	Solutia Inc. (1997)

Texanol benzyl phthalate is stable at normal temperatures and pressure, but it is a strong oxidizer and therefore is a fire and explosion hazard (Solutia Inc., undated). Upon decomposition, it emits toxic fumes of carbon monoxide and carbon dioxide (Solutia Inc., 1997).

## 2.3 Commercial Availability

Monsanto Co. has produced plasticizer products from 2,2,4-trimethylpentane-1,3-diol 1-isobutyrate or from Texanol since at least the 1960s. Solutia, Inc. (Bridgeport, NJ), Monsanto's plasticizer division after divestment, markets Texanol benzyl phthalate as Santicizer<sup>®</sup> 278 (SRI, 1999; Solutia Inc., 1997, 1999).

## 3.0 PRODUCTION PROCESSES

Texanol benzyl phthalate may be prepared by treating the diol monoisobutyrate with phthalic anhydride followed by treatment with benzyl chloride and neutralization. For example, a phthalate ester plasticizer mixture of 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate benzyl phthalate and butyl benzyl phthalate has been prepared by esterification of 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate with phthalic anhydride at 130 to 150 °C, treating the unreacted phthalic anhydride with butanol at 100 to 115 °C, neutralizing, and treating with benzyl chloride at 110 to 130 °C in the presence of a tertiary amine (Mottez and Lejeune, 1971). Monsanto Co.

has patented a process to produce the benzyl phthalate of CASRN 16883-83-3 from the diol 1-isobutyrate. High yield of a plasticizer for chloroethylene polymers has been prepared by the reaction of phthalic anhydride and 2,6,6,8-tetramethyl-4-oxa-3-oxononan-7-ol, the diol 1-isobutyrate, at 124 °C, to which triethylamine and benzyl chloride is added. The mixture is heated at 138 °C for an hour, washed with water, and dehydrated at 125 to 130 °C to give 94.7% of the desired product (Dill, 1967).

#### **4.0 PRODUCTION AND IMPORT VOLUMES**

Texanol benzyl phthalate is listed on the Environmental Protection Agency (EPA) HPV Chemicals list with an annual production of 6.73 to 8.90 million lb (3050 to 4040 metric tons) (U.S. EPA, 1998). No data on imports were found.

#### **5.0 USES**

Texanol benzyl phthalate, offering low volatility, good permanence, and aggressive solvating characteristics, is a versatile plasticizer for use in many resin systems. It is especially effective in vinyl systems that require extremely good migration resistance, such as in automotive sealants, and in caulks and sealants that are based on chlorinated rubber, butyl rubber, polysulfides, or polyurethane (Solutia Inc., undated). Specifically, it serves as a plasticizer for water-blown methylene diisocyanate (MDI)-based polyurethane foams (Gabbard and Bhombal, 1993), poly(vinyl chloride)-containing conductive fillers, and electromagnetic shields (Ikeda, 1993). The compound is also helping in the development of high-performance products in paints and coatings, with its ability to increase durability, adhesion, and resistance to water spotting (Solutia Inc., undated). Other applications include its use as a yellowing inhibitor for thermoplastic polycarbonate resins exposed to gamma radiation (Chung, 1996), as a solvent for pressure-sensitive copying paper giving copies improved resistance to fading (Allart and Guillaume, 1986), and for interlayers of sandwich glass for cars and buildings (Hasegawa, 1994). The amount of Texanol benzyl phthalate varies; < 5% and up to 50% have been reported



(Courtalds Aerospace Inc., 1993; Engineered Fabrics Corp., 1993). A nonslip flight deck compound (polyamine curing agent) contained 20% (Prod. Res. Chem. Corp., 1990).

## **6.0 ENVIRONMENTAL OCCURRENCE AND PERSISTENCE**

The results of biodegradation tests suggest that Texanol benzyl phthalate would be classified as "inherently biodegradable" (Solutia Inc., 1997).

Under aerobic and anaerobic conditions, studies reveal that many phthalate esters are degraded by a wide range of bacteria and actinomycetes. Standardized aerobic biodegradation tests with sewage sludge inocula show that within 28 days approximately 50% ultimate degradation occurs. Biodegradation is, therefore, expected to be the dominant pathway in surface soils and sediments. In the atmosphere, photodegradation via free radical attack is the anticipated dominant pathway. The half-life of many phthalate esters is ca. 1 day in the air, from < 1 day to 2 weeks in surface and marine waters, and from < 1 week to several months in soils. Bioaccumulation of phthalate esters in the aquatic and terrestrial food chain is limited by biotransformation (Staples et al., 1997).

## **7.0 HUMAN EXPOSURE**

Used as a plasticizer, Texanol benzyl phthalate is not chemically bound to the product and therefore may leak into the surrounding medium (Autian, 1973; Jaeger and Rubin, 1972; both cited by Harris et al., 1997). The likely routes of exposure to the compound are skin contact and inhalation (Solutia Inc., 1997).

## **8.0 REGULATORY STATUS**

OSHA and ACGIH have not established specific exposure limits for Texanol benzyl phthalate but have done so for several dialkyl phthalate esters. For dimethyl, diethyl, and dibutyl phthalates, the OSHA permissible exposure limit (PEL) and the ACGIH threshold limit value (TLV) are both 5 mg/m<sup>3</sup> as an 8-hour time-weighted average (TWA). For bis(2-ethylhexyl) phthalate (DEHP), the OSHA PEL and ACGIH TLV are 5 mg/m<sup>3</sup> as an 8-hour TWA, while the

short-term exposure limit (STEL) is 10 mg/m<sup>3</sup> (Solutia Inc., 1997). Monsanto has recommended a TWA of 5 mg/m<sup>3</sup> for Texanol benzyl phthalate (MLD Inf. Serv., 1999).

When discarded, Texanol benzyl phthalate is not a hazardous waste, as defined by the Resource, Conservation and Recovery Act (RCRA). It is also considered not hazardous under the Department of Transportation (DOT) regulations. The compound, however, is listed in the Toxic Substances Control Act (TSCA) Inventory (Solutia Inc., 1997).

Texanol benzyl phthalate is included in the U.S. EPA High Production Volume (HPV) Challenge Program. Under this program, EPA has sought private-sector sponsors to conduct voluntary research on HPV chemicals. Texanol benzyl phthalate is fully sponsored for Screening Information Data Set (SIDS) testing by 2000 by Solutia, Inc., as a member of the Chemical Manufacturers Association (CMA) Phthalate Esters (PE) Panel HPV Testing Group. (When the seven companies of the PE Panel are checked individually, Solutia, Inc., is the only one that lists Texanol benzyl phthalate.) The tests agreed to are acute toxicity, chronic toxicity, developmental/reproductive toxicity, mutagenicity, ecotoxicity, and environmental fate (U.S. EPA, 1999).

## **9.0 TOXICOLOGICAL DATA**

### **9.1 General Toxicology**

Toxicology information is from Material Safety Data Sheets without experimental details. No data were found in biomedical literature or the TSCA Test Submissions databases.

#### **9.1.1 Human Data**

Based on toxicity studies, Texanol benzyl phthalate does not cause significant eye or skin irritation or toxicity, nor significant inhalation or ingestion toxicity (Solutia Inc., 1997).

#### **9.1.2 Chemical Disposition, Metabolism, and Toxicokinetics**

No data on disposition, metabolism, or toxicokinetics were available.

### 9.1.3 Acute Exposure

Acute toxicity values for Texanol benzyl phthalate are presented in **Table 1**.

**Table 1. Acute Toxicity Values for Texanol Benzyl Phthalate**

Species (sex and strain)	Route	Acute Toxicity Value	Reference(s)
rabbit (sex and strain n.p.)	dermal	LD <sub>50</sub> > 10,000 mg/kg (21.978 mmol/kg)	MDL Inf. Serv. (1999); Solutia Inc. (1997)
rat (sex and strain n.p.)	oral	LD <sub>50</sub> > 15,800 mg/kg (34.725 mmol/kg)	MDL Inf. Serv. (1999); Solutia Inc. (1997)
<b>Aquatic Organisms</b>			
Daphnia magna	NA	EC <sub>50</sub> , 48-hour > 100 mg/L (0.220 mM)	Solutia Inc. (1997)
Fathead minnow	NA	LC <sub>50</sub> , 96-hour > 100 mg/L (0.220 mM)	Solutia Inc. (1997)
Rainbow trout	NA	LC <sub>50</sub> , 96-hour > 100 mg/L (0.220 mM)	Solutia Inc. (1997)
Algae (chlorophyll)	NA	EC <sub>50</sub> , 96-hour > 100 mg/L (0.220 mM)	Solutia Inc. (1997)

Abbreviations: EC<sub>50</sub> = effective concentration in 50% of test organisms; LC<sub>50</sub> = lethal concentration in 50% of test animals; LD<sub>50</sub> = lethal dose in 50% of test animals; NA = not applicable; n.p. = not provided

Texanol benzyl phthalate, when applied to the skin and eyes of six rabbits for a period of 24 hours, was reported to be practically non-irritating (MDL Inf. Serv., 1999; Solutia Inc., 1997). In aquatic organisms, the compound is "practically nontoxic" (Solutia Inc., 1997).

### 9.1.4 Short-Term and Subchronic Exposure

No short-term or subchronic data were available.

### 9.1.5 Chronic Exposure

No chronic exposure data were available.

### 9.1.6 Antitoxicity

No antitoxicity data were available.

## 9.2 Reproductive and Teratological Effects

No reproductive or teratological data were available.

### 9.3 Carcinogenicity

No carcinogenicity data were available.

### 9.4 Genotoxicity

Monsanto studies found no genetic changes when Texanol benzyl phthalate was evaluated in standard tests using bacterial cells (Solutia Inc., 1997).

### 9.5 Immunotoxicity

No immunotoxicity data were available.

## 10.0 STRUCTURE-ACTIVITY RELATIONSHIPS

A study of 18 commercial phthalate esters with alkyl chains ranging from one to 13 carbons found an eight order of magnitude increase in octanol-water coefficients ( $K_{ow}$ ) and a four order of magnitude decrease in vapor pressure with increasing length. This increase in  $K_{ow}$  and decrease in vapor pressure results in increased partitioning of the phthalate esters to suspended solids, soils, sediments, and aerosols (Staples et al., 1997).

### Butyl Benzyl Phthalate

The NTP has previously conducted comprehensive toxicology and carcinogenicity studies of the structurally related butyl benzyl phthalate which are briefly summarized below.

#### Reproductive Toxicity and Teratology Studies

Groups of male F344/N rats given 20, 200, or 2200 mg/kg body weight butyl benzyl phthalate daily in feed for 10 weeks resulted in significantly decreased prostate gland, right cauda, right epididymis, and right testis weights at the highest dose versus those of the controls (NTP, 1997). Additionally, the epididymal spermatozoal concentrations in males given the 200 and 2200 mg/kg levels were significantly less than the controls. Females mated to 20 and 200 mg/kg males exhibited maternal body weights similar to those of females mated to control males. Litter

data between the two dose groups and controls were also similar. Females mated to 2200 mg/kg males were initially found to be sperm positive; however, at necropsy, none of the females were pregnant. The fertility indices of the males and females were observed to be significantly lower than those of the controls.

### Carcinogenicity Studies

In a 2-year study, groups of male F344/N rats were given 120, 240, or 500 mg/kg body weight butyl benzyl phthalate daily in feed and females were given 300, 600, or 1200 mg/kg/day (NTP, 1997). At the highest dose, the incidences of pancreatic acinar cell adenoma and adenoma or carcinoma (combined) were significantly greater in males than those in the controls. In females, the incidence of transitional epithelial hyperplasia was significantly greater than that in the controls. Specifically, two transitional epithelial papillomas in the urinary bladder were seen.

### Genotoxicity Studies

At concentrations up to 11,550 µg/plate butyl benzyl phthalate in *Salmonella typhimurium* strains TA98, TA100, TA1535, and TA1537, no mutagenic response was obtained, in the presence or absence of metabolic activation (S9) (NTP, 1997). *In vitro* studies with L5178Y mouse lymphoma cells and cultured Chinese hamster ovary cells, both conducted with and without S9, were also negative. In germ cells of male *Drosophila melanogaster*, no induction of sex-linked recessive lethal mutations was observed. In contrast to these results, butyl benzyl phthalate gave positive responses in two *in vivo* mouse studies. In one experiment, sister chromatid exchanges were weakly positive at 23 and 42 hours. In the other study, chromosomal aberrations were induced in bone marrow cells 17 hours after intraperitoneal injection of 5000 mg/kg of the compound.

## 11.0 ONLINE DATABASES AND SECONDARY REFERENCES

### 11.1 Online Databases

#### Chemical Information System Files

SANSS (Structure and Nomenclature Search System)

TSCAPP (Toxic Substances Control Act Plant and Producers)

TSCATS (Toxic Substances Control Act Test Submissions)

#### DIALOG Files

CEH (Chemical Economics Handbook)

DIOGENES

#### National Library of Medicine Databases

EMIC and EMICBACK (Environmental Mutagen Information Center)

#### STN International Files

BIOSIS

CANCERLIT

CAPLUS

CHEMLIST

EMBASE

HSDB

MEDLINE

Registry

RTECS

TOXLINE

TOXLINE includes the following subfiles:

Toxicity Bibliography	TOXBIB
International Labor Office	CIS
Hazardous Materials Technical Center	HMTC
Environmental Mutagen Information Center File	EMIC
Environmental Teratology Information Center File (continued after 1989 by DART)	ETIC
Toxicology Document and Data Depository	NTIS
Toxicological Research Projects	CRISP
NIOSH <sup>®</sup>	NIOSH
Pesticides Abstracts	PESTAB
Poisonous Plants Bibliography	PPBIB
Aneuploidy	ANEUPL
Epidemiology Information System	EPIDEM
Toxic Substances Control Act Test Submissions	TSCATS
Toxicological Aspects of Environmental Health	BIOSIS
International Pharmaceutical Abstracts	IPA
Federal Research in Progress	FEDRIP
Developmental and Reproductive Toxicology	DART

Databases Available on the Internet

Phytochemical Database (Agricultural Research Service)

In-House Databases

CPI Electronic Publishing Federal Databases on CD-ROM

Current Contents on Diskette®

The Merck Index, 1996, on CD-ROM

**11.2 Secondary References**

Lewis, R.J., Sr. 1993. Hawley's Condensed Chemical Dictionary, 12<sup>th</sup> ed. Van Nostrand Reinhold Company, New York, NY.

**12.0 REFERENCES**

Allart, P. J., and C. A. Guillaume. 1986. Pressure-sensitive mark recording systems. Eur. Pat. Appl. 13 pp. Abstract from CA 93:58282.

Autian, J. 1973. Toxicity and health threats of phthalate esters: Review of the literature. Environ. Health Perspect. 4:3-26. Cited by Harris et al. (1997).

Chung, J. Y. J. 1996. Aromatic carboxylate esters as yellowing inhibitors for thermoplastic polycarbonate resins exposed to gamma radiation. Eur. Pat. Appl. 7 pp. Abstract from CA 125:277613.

Courtaulds Aerospace Inc. 1993. Material Safety Data Sheet. Part No./Trade Name: PR-1201-RLS, BASE. MSDS Serial No. BVZYB. Courtaulds Aerospace Inc., Glendale, CA. Internet address: <http://MSDS.PDC.CORNELL.EDU/msds/hazcom/392/145524.txt>. Prepared June 17, 1993. Last accessed May 25, 1999.

Dill, D.R. 1967. Benzyl 2,6,6,8-tetramethyl-4-oxa-3-oxononan-7-yl phthalate plasticizer. French Pat. 3 pp. Abstract from CA 67:33305.

Engineered Fabrics Corp. 1993. Material Safety Data Sheet. Part No./Trade Name: 5958C. MSDS Serial No. BWBPV. Engineered Fabrics Corp., Rockmart, GA. Internet address: <http://MSDS.PCD.CORNELL.EDU/msds/hazcom/392/145649.txt>. Prepared October 1, 1993. Last accessed May 25, 1999.

Gabbard, J. D., and A. H. Bhombal. 1993. Manufacture of flexible polyurethane foams in presence of plasticizers. PCT Int. Appl. 32 pp. Abstract from CA 119:227449.

Harris, C. A., P. Henttu, M. G. Parker, and J. P. Sumpter. 1997. The estrogenic activity of phthalate esters *in vitro*. Environ. Health Perspect. 105(8):802-811.

Hasegawa, R. 1994. Compositions for interlayers of sandwich glass for automobiles and buildings. Jpn. Kokai Tokkyo Koho. 4 pp. Abstract from CA 122:62360.

Ikeda, N. 1993. Antistatic vinyl chloride resin compositions containing conducting fibers. Jpn. Kokai Tokkyo Koho. 5 pp. Abstract from CA 119:182154.

Jaeger, R. J., and R. J. Rubin. 1972. Migration of a phthalate ester plasticizer from polyvinyl chloride blood bags into stored human blood and its localization in human tissues. New Engl. J. Med. 287:1114-1118. Cited by Harris et al. (1997).

Mettang, T., F.-P. Fischer, U. Kuhlmann and A. W. Rettenmeier. Plasticizers in patients with end-stage renal failure—Aspects of exposition and toxicity. Nieren- und Hockdruckkrankheiten 26(Suppl. 1):S7-S12. [German with English abstract]. Abstract from EMBASE 97355293.

Mottez, P., and R. Lejeune. 1973. Phthalic acid ester products for use as plasticizers in vinyl polymers. Ger. Offen. 13 pp. Abstract from CA 75:89161.

MDL Inf. Serv. 1999. Texanol benzyl phthalate profile. Database available from STN's MDL Information Systems, Inc.

NTP (National Toxicology Program). 1997. Toxicology and carcinogenesis studies of butyl benzyl phthalate (CAS No. 85-68-7) in F344/N rats (feed studies). Technical Report No. 458. National Toxicology Program, Research Triangle Park, NC. Internet address: <http://ntp-server.niehs.nih.gov/htdocs/LT-studies/tr458.html>. Report dated September 1997. Last accessed May 17, 1999.

Prod. Res. Chem. Corp. 1990. Material Safety Data Sheet. Part No./Trade Name: PR-1539-U, PART A. MSDS Serial No. BPEFGW. Products Research and Chemical Corp., Glendale, CA. Internet address: <http://MSDS.PCD.CORNELL.EDU/msds/hazcom/159/29315.txt>. Prepared November 27, 1990. Last accessed May 25, 1999.

Solutia Inc. [undated] Santicizer<sup>®</sup> 278. Monomeric plasticizer offering permanence that approximates polymeric. Coatings Performance Materials—Global Solutions. Performance Materials Data Sheet. Publication No. 2311536A. Internet address: <http://www.coatings-solutia.com/docs/PDS/S-278.htm>. Last accessed May 25, 1999.

Solutia Inc. 1997. Santicizer<sup>®</sup> 278. Material Safety Data Sheet. Internet address: <Http://domino.solutia.com/solutia/...8c4df06256539006ffadc?OpenDocument>. Last updated November 9, 1997. Last accessed May 25, 1999.



Solutia Inc. 1999. Delaware River Plant. Worldwide Locations. Internet address: <http://www.solutia.com/Investor/WorldwideLocations/Delaware.html>. Last accessed May 25, 1999.

SRI (Stanford Research Institute). 1999. Chemical Economics Handbook. Menlo Park, CA: SRI International. DIALOG (R) File 359. Last accessed May 28, 1999.

Staples, C. A., D. R. Peterson, T. F. Parkerton, and W. J. Adams. 1997. The environmental fate of phthalate esters: A literature review. *Chemosphere* 35(4):667-749. Abstract from TOXLINE 1997:129758.

U.S. EPA (U.S. Environmental Protection Agency). 1998. OPPT High Production Volume Chemicals. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Washington, DC. Internet address: <http://www.epa.gov/opptintr/chemtest/hpv.htm>. (11/20/97).

U.S. EPA (U.S. Environmental Protection Agency). 1999. HPV Challenge Summary Report—September 14, 1999. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Washington, DC. Internet address: <http://www.epa.gov/opptintr/chemrtk/smrestbl.htm>. Last revised on September 22, 1999. Last accessed on September 28, 1999.

White, H.F., C.W. Davisson, and V.A. Yarborough. 1964. Determination of isomer distribution ratio in mixtures of the monoisobutyrate of 2,2,4-trimethyl-1, 3-pentanediol by nuclear magnetic resonance. *Anal. Chem.* 36(8):1659-1661.

## ACKNOWLEDGEMENTS

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**APPENDIX A: UNITS AND ABBREVIATIONS**

°C = degrees Celcius

DOT = Department of Transportation

EC<sub>50</sub> = effective concentration in 50% of the test organisms

EPA = Environmental Protection Agency

LC<sub>50</sub> = lethal concentration in 50% of test animals

LD<sub>50</sub> = lethal dose in 50% of test animals

MDI = methylene diisocyanate

mg/kg = milligram(s) per kilogram

mg/L = milligram(s) per liter

mM = millimolar

mmol/kg = millimole(s) per kilogram

mol. wt. = molecular weight

NA = not applicable

n.p. = not provided

OPPT = Office of Pollution Prevention and Toxics

PEL = permissible exposure limit

RCRA = Resource, Conservation and Recovery Act

SIDS = Screening Information Data Set

STEL = short-term exposure limit

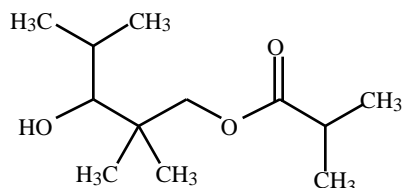
TLV = threshold limit value

TSCA = Toxic Substances Control Act

TWA = time-weighted average

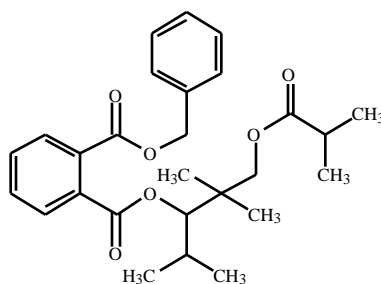
**APPENDIX B: DISCUSSION REGARDING THE CASRN<sub>s</sub> ASSIGNED TO TEXANOL BENZYL PHTHALATE**

Texanol benzyl phthalate is the trade name of a phthalate diester prepared from 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Texanol, CASRN 25265-77-4), benzyl alcohol, and phthalic acid.



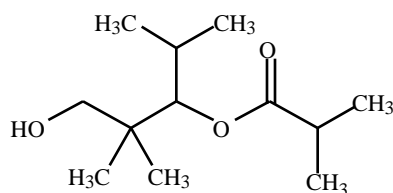
Note that the Texanol structure does not specify whether the attachment of the isobutyryl moiety in Texanol is at the 1-OH (primary alcohol) or the 3-OH (secondary alcohol) group of the diol. The CASRN of 2,2,4-trimethyl-1,3-pentanediol 1-isobutyrate is 77-68-9. The CASRN of 2,2,4-trimethyl-1,3-pentanediol 3-isobutyrate is 18491-15-1. Lewis (1993) lists the diol 1-isobutyrate as having boiling point 180-182 °C at 125 mm Hg and gives its uses as an intermediate in the manufacture of plasticizers, surfactants, pesticides, and resins. Most patented processes for producing the monoester by the self-condensation of isobutyraldehyde state that the product is this ester. White et al. (1964) of Union Carbide reported that Texanol (at that time a registered U.S. trademark of Tennessee Eastman Chemical Co.) comprised the monoesters in the concentrations 59% primary ester-secondary alcohol and 41% secondary ester-primary alcohol, as determined by nuclear magnetic resonance. The monoesters were said to be not easily separable by fractional distillation. Eastman Kodak, however, patented a process in 1963 that produced the diol 1-isobutyrate in 90.0% yield. Any diol 3-isobutyrate yield would have been  $\leq 1.4\%$  (Hagemeyer and Wright, 1963). Yet the monoester reported by Texas Eastman Co. in the TSCA Plant and Producers database in the late 1970s was Texanol. Union Carbide Caribe produced the diol 1-isobutyrate in Puerto Rico (TSCAPP, 1983).

The U.S. Environmental Protection Agency (EPA) Office of Pollution Prevention and Toxics (OPPT) lists the compound with CASRN 16883-83-3 on its High Production Volume list (U.S. EPA, 1998).



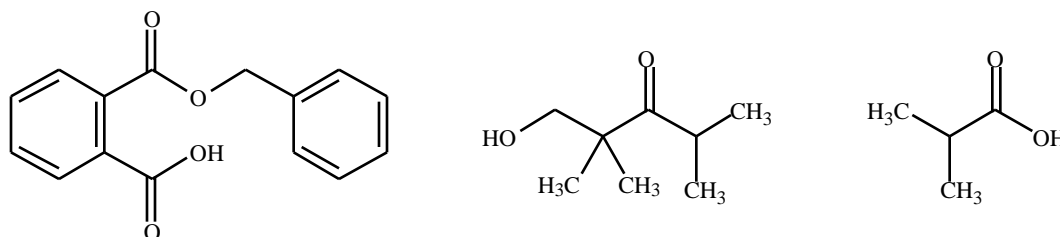
2,2,4-Trimethyl-1,3-pentanediol 1-isobutyrate benzyl phthalate

The isobutyryl moiety in this compound is specified as being attached to the 1-OH group of the diol. 2,2,4-trimethyl-1,3-pentanediol 1-isobutyrate (CASRN 77-68-9) is not on the OPPT HPV list whereas Texanol is. Monsanto is listed as the sponsor for toxicological studies of 16883-83-3. The Monsanto successor, Solutia, markets the product as Texanol benzyl phthalate and has used this CASRN almost exclusively, including in TSCAPP (1983). The assignment of CASRN 16883-83-3 to the compound appears to be erroneous, however. If the compound is prepared from Texanol, then the product is likely to be a mixture of the compound with CASRN 16883-83-3 and the product formed from the diol 3-isobutyrate. The Solutia Material Safety Data Sheet for Texanol benzyl phthalate, however, sheds no light on the purity of the product. For example, a pure compound is expected to have a sharp boiling point and melting/freezing point. However, no freezing point is given for the product, and the boiling point is given as  $> 300^{\circ}\text{C}$  at standard atmospheric pressure. Only one value is given for the boiling point at reduced pressure ( $243^{\circ}\text{C}$  at 10 mm Hg).



2,2,4-Trimethyl-1,3-pentanediol isobutyrate (CASRN 18491-15-1)

The reaction product of Texanol with benzyl phthalate (CASRN 32333-99-6) is depicted in the CAS Registry File without specification of the isobutyryl moiety linkage:



The abstracts and indexing of 6 patents and 2 articles indexed by CASRN 16883-83-3 in *Chemical Abstracts* between 1967 and 1993 were examined. The records include 3 Monsanto patents from 1962, 1967, and 1979. Three of the 8 abstracts give sufficient information to assign 16883-83-3 to the product. One is a 1967 Monsanto preparation patent (Dill, 1967) that claims production of 16883-83-3 in 94.7% yield from the diol 1-isobutyrate. Abstracts of four patents, published between 1993 and 1996, were found in *Chemical Abstracts* indexed by CASRN 32333-99-6, the product expected from Texanol. Three records name the product as if it were produced from Texanol. One of these is a Monsanto patent that is clearly indexed as having been produced from Texanol; its CASRN is indexed as the reactant with benzyl phthalate, and its product name Santicizer 278 is indexed. Both Texanol and the diol 1-isobutyrate were on the original TSCA Inventory candidate list published in 1977.

Several *Chemical Abstracts* records on the preparation of Texanol, the diol 1-isobutyrate, and diol 3-isobutyrate were examined. Although these monoesters of 2,2,4-trimethylpentane-1,3-diol are produced by self-condensation of isobutyraldehyde in the presence of a basic catalyst, there was no overlap between the 12 preparation records for Texanol and the 32 for the diol 1-isobutyrate (14 of which also mentioned the diol 3-isobutyrate). cursory examination of these records for yields of the monoesters found a 69% yield for Texanol recovery from the reaction mixture by azeotropic distillation. About half of the diol 1-isobutyrate records were examined. Only 2 records gave yields for both monoesters (one reported 37% 3-isobutyrate and 59% 1-isobutyrate; another reported 22% 3-isobutyrate and 24% 1-isobutyrate). Others reported yields of 48 to 93% 1-isobutyrate. Is Texanol produced today as a pure compound or primarily as the diol 1-isobutyrate? ChemFinder (1999) gave its structure as the diol 1-isobutyrate. The OECD SIDS review of Texanol gave its boiling point as 244 °C and its melting point as -50 °C. Eastman Chemical Co. is one of two Texanol suppliers listed in *Chemcyclopedia 99* (Rodnan, 1998). Its MSDS for Texanol states that the typical composition may vary, gives the same melting point, and gives a boiling point of 255 to 260.5 °C. The range might indicate that Texanol is a mixture of the 1- and 3-isobutyrate esters.

## References Cited

- ChemFinder. 1999. 2,2,4-Trimethyl-1,3-pentanediol isobutyrate. Internet address: <http://www.chemfinder.com/cgi-win/cfserver.exe/>. Last accessed August 27, 1999.
- Dill, D.R. 1967. Benzyl 2,6,6,8-tetramethyl-4-oxa-3-oxononan-7-yl phthalate plasticizer. French Pat. 3 pp. Abstract from CA 67:33305.
- Hagemeyer, H.J., and H.N. Wright, Jr. 1963..Process for the production of glycol monoesters from aldehydes. U.S. Patent 3,091,632. Filed on July 6, 1961. Patented on May 28, 1963.
- Lewis, R.J., Sr. 1993. Hawley's Condensed Chemical Dictionary, 12<sup>th</sup> ed. Van Nostrand Reinhold Company, New York, NY.
- Rodnan, N., Ed. 1998. Chemcyclopedia 99. The Manual of Commercially Available Chemicals. Vol. 17. American Chemical Society, Washington, DC.
- TSCAPP (Toxic Substances Control Act Plant and Producers). 1983. Texanol. Profile available on CIS (Chemical Information System). Last accessed August 29, 1999.
- White, H.F., C.W. Davisson, and V.A. Yarborough. 1964. Determination of isomer distribution ratio in mixtures of the monoisobutyrate of 2,2,4-trimethyl-1, 3-pentanediol by nuclear magnetic resonance. Anal. Chem. 36(8):1659-1661.